Helping understand and manage interactions between people and Asian elephants in a contested landscape of Hassan, Karnataka

Report submitted by

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Executive summary

Overlap and close contact of elephants and humans has been accompanied by an extensive loss of property and life for both protagonists, especially across the densely-peopled elephant ranges of Asia. Our study was carried out in the Alur, Sakleshpur and Somawarpet taluks administered under Hassan and Madikeri forest divisions of Karnataka state in southern India, an area that has been the focus of negative interactions between elephants and humans. The landscape here is dominated by coffee plantations interspersed with forest fragments, paddy fields, and monoculture plantations such as Acacia and *Eucalyptus*. In this study, we monitored 85 villages, home to about 35,000 people dependent on plantations and agriculture, which are also used by nearly 30 elephants. Elephant locations, and incidents of crop damage, as well as human casualties were monitored on a daily basis and through informant networks between March 2015 and February 2016. Elephant's use of mosaic of habitats varied between day and nightime. Forest remnants and monoculture plantations such as teak, Eucalyptus, and Acacia are important as refuges for elephants and at night, agriculture habitat was used more frequently while moving between refuge areas, leading to high incidents of crop damage. GPS locations of elephants and conflict incidents were recorded along with habitat variables.190 incidents of crop damage were recorded throughout the year, of which, damage to paddy was highest, especially during the harvest season (October to December), followed by banana during the January-February period. Crop damage incidents by elephants during the present study were lower as compared to the incidents reported in the Forest Department records between 2000 - 2009 during pre-capture and removal of elephants carried out in 2014.

Data on human fatalities in encounters with elephants were obtained from the state Forest Department records and each incident was investigated to understand the circumstances of these incidents. Between 2010 and 2016, 30 human deaths were reported, which instilled a sense of fear and anger amongst local communities towards elephants. A majority of human deaths occurred on roads during the early morning (6 - 10 AM) and evening hours (4 - 6 PM), usually when people were walking between home and work. People aged between 40 - 60 years seemed more vulnerable to direct encounters with elephants compared with any other age class. An analysis of the circumstances of these deaths revealed that a majority of them occurred due to a lack of knowledge about elephant presence, and poor safety at work or at home. During the study, we have established the nucleus of an Elephant Information Network with 178 informants with whom we exchanged information about elephant presence in the region. During our study period, we received 203 calls from people across 45 villages, of which 61%conveyed information on elephant locations, 29% reported crop damage by elephants, and 10% enquired about the whereabouts of elephants.

Our results suggest both a need and an opportunity to test early intimation systems to notify people about elephant presence, not only using sensors to detect elephant presence, but also by involving local communities, as a way of reducing risk to humans interactions with elephants and protection of crops. Doing this, we believe, can help us distinguish situations where elevated risks may be tied to specific locations (problem locations), from risks that may be associated with specific elephants (problem animals). This understanding of the circumstances of conflict, along with an understanding of the needs of people and elephants in this landscape, can promote safer coexistence, which appears to be the most important management goal for this region, given that all previous efforts to remove elephants from this landscape may not be appropriate keeping moral and ethical concerns in conservation of elephants and to achieve sustainable human-elephant conflict resolution in the long run.

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Introduction

Increasing anthropogenic pressures on elephant habitats, as well as the close proximity of farm lands/plantations with elephant habitats, have created opportunities for greater contact between people and elephants, often leading to loss of life on both sides, besides damage to crops and property. Given that elephants in India range widely outside protected areas into regions of high human density (Leimgruber *et al*. 2003; Madhusudan *et al.* 2015), human-elephant interactions poses a challenge not only for local communities, but also to government agencies, and conservation organizations. Chronic or acute conflict frequently leads to responses ranging from chasing elephants, translocation and capture, to retaliatory persecution, but these responses rarely resolve conflicts sustainably, empower communities to reduce human and material losses, or help in the conservation of elephants. Despite continuing efforts, in areas where elephants unavoidably overlap with human dwelling and agriculture, locally appropriate and sustainable conflict mitigation measures that enable safer human-elephant coexistence have remained elusive. Sustainable resolution of human-elephant conflict is pivoted on a range of ecological, socio-economic, institutional and technical factors (Fernando *et al.* 2008; Graham *et al.* 2010). Hence, identifying locally appropriate measures that are practical and participatory would further sustainable and effective management mechanisms to deal with human–elephant conflict.

In India, there is a large human population that lives inside or on the fringes of forests on which they are dependent for livelihood (Banerjee and Madhurima 2013). Beyond India too, Asian elephant habitats are under threat from expansion of agriculture lands and developmental activities which have resulted in fragmentation of forests (Leimgruber *et al*. 2003; Blake and Hedges 2004). These fragmented habitats too are under extensive regimes of anthropogenic pressures (e.g., livestock grazing, fuel wood gathering) that compromise their ability to sustain elephants. Pocketed elephant populations with reduced access to resources have thus been pushed out of their natural habitats into adjoining human-modified habitats, leading to intense human-elephant conflicts (Desai 1991; Madhusudan 2003). Complicating matters further is the phenomenal ability of elephants themselves to learn and adapt to changes taking place within their ranges, which has also contributed to an increase in overlap and interactions between people and elephants. Thus, conflicts between people and elephants in India result in around 400 people and 100 elephants losing their lives annually, besides intense damages to crops in India (Rangarajan *et al*. 2010). Hence, reducing conflicts between people and elephants are a high priority, especially in elephant ranges that lie within human-dominated production landscapes.

It is known that the availability of food, water, and cover determine elephant distribution and their use of habitat mosaics in altered landscapes (Fernando *et al*. 2005). In fragmented landscapes, remnant forest patches and habitats with tree cover could provide important resources and serve as refugia for many wildlife species including elephants outside Protected Areas (Mudappa and Raman, 2007; Graham *et al*. 2009; Bal *et al*. 2011).Thus, in such habitats, information on elephant

distribution, use of habitats and interactions with humans is crucial to elevate the prospects of safe coexistence in areas that currently witness severe conflict.

Meanwhile, a range of preventive measures such as fences and elephant proof trenches have been used to mitigate conflict, and their results, at best, are mixed in managing human-elephant conflict. As currently implemented, reactive measures such as translocation, capture or elephant drives too have rarely yielded sustainable reduction of conflict (Fernando *et al.* 2012). Often, measures such as captures are undertaken in the face of intense public pressure, despite the experience and knowledge of managers and scientists suggesting the unsatisfactory nature of these interventions. On the other hand, experience also suggests that careful, site-specific understanding of human-elephant relationships can yield pro-active measures that are locally appropriate, and more importantly, enable the active involvement of stakeholders, an aspect often overlooked in the management of human-elephant conflict.

The villages of the Alur-Yeslur-Kodlipet region in Karnataka have witnessed high levels of human-elephant conflict over the last two decades, owing to the presence of 25 elephants in the region (Appayya and Desai 2007;Srinivasaiah and Sinha 2012). Such intense conflict between people and elephants in an area with negligible natural habitats forced a task force constituted by the High Court of Karnataka to recommend removal of elephants from the region *after* closing two possible routes through which re-colonisation could occur. Although 22 elephants were captured in 2013–2014 in order to mitigate conflict, the key conditionality laid down by the task force—of closing re-colonization routes before capture—was not implemented. Therefore, even after one of the large-scale captures of elephants in India, the area has been re-colonised by elephants and frequent crop damage and human deaths continue to occur in the landscape, with two deaths occurring in the year 2016. Hence, given that overlap between elephants and people appears inevitable in the short-term, there is both opportunity and need to understand human-elephant relationships and identify locally suitable and sustainable measures that would help promote safer human–elephant coexistence in this region.

In this report, we focus on understanding elephant distribution and habitat use in this landscape mosaic, investigating spatial and temporal distribution of conflict incidents while assessing the value and opportunity of building an elephant information network with local community and stakeholders as a possible option to deal with human-elephant conflict in the study region. This study was carried out between March 2015 and February 2016 to:

- Assess distribution and habitat use of elephants in fragmented habitats of Hassan and Madikeri Divisions, specifically, in the forest ranges of Alur, Yeslur, Sakaleshpur, and Somwarpet
- Investigate spatial and temporal patterns of human-elephant conflict in the above landscapes
- Examine circumstances leading to each human fatality in the area due to elephants

- Evaluate development of participatory elephant information network with the involvement of local community

Study Area

The southern Indian State of Karnataka, which intersects the Western and Eastern Ghats, presently harbours about 5,300–6,200 wild elephants over an area of 14,500 sq. km, which is about one-fifth of the elephant population of the country (KETF 2012). The region bounded by the Hassan and Madikeri divisions of the Karnataka Western Ghats largely comprises of coffee plantations and paddy fields with forest fragments ranging from 150 – 300 hectares in size. The study area chosen was a set of 85 villages located in the Alur, Sakleshpur and Somwarpet Taluk, covering an area about 207 km^2 (Figure 1). The study region is home to nearly thirty elephants and about 35,000 people dependent on coffee plantations and agriculture for their livelihoods. The area is dominated by coffee plantations in the upslope areas, with paddy grown in the valleys. Most of the coffee is owned by small growers (less than 10 ha) who also cultivate paddy seasonally between October and January (Anonymous 2016). However, there are also a few big national and multinational companies such as Tata Coffee Limited and Indian Build Corporation (IBC) own coffee plantations. There are several forest fragments, monoculture plantations dominated by *Acacia*, teak, and *Eucalyptus*, and also a few abandoned coffee plantations in the study region. Elephants in the region invariably forage or move through plantations and subsistence agriculture, which inevitably results in high incidence of conflicts (Appayya and Desai 2007). Physical barriers such as electric fences and trenches have also been widely deployed to protect crops and coffee plantations. With elephants often being present on either side of these barriers, crop damage and threat to human life remain important concerns in the region.

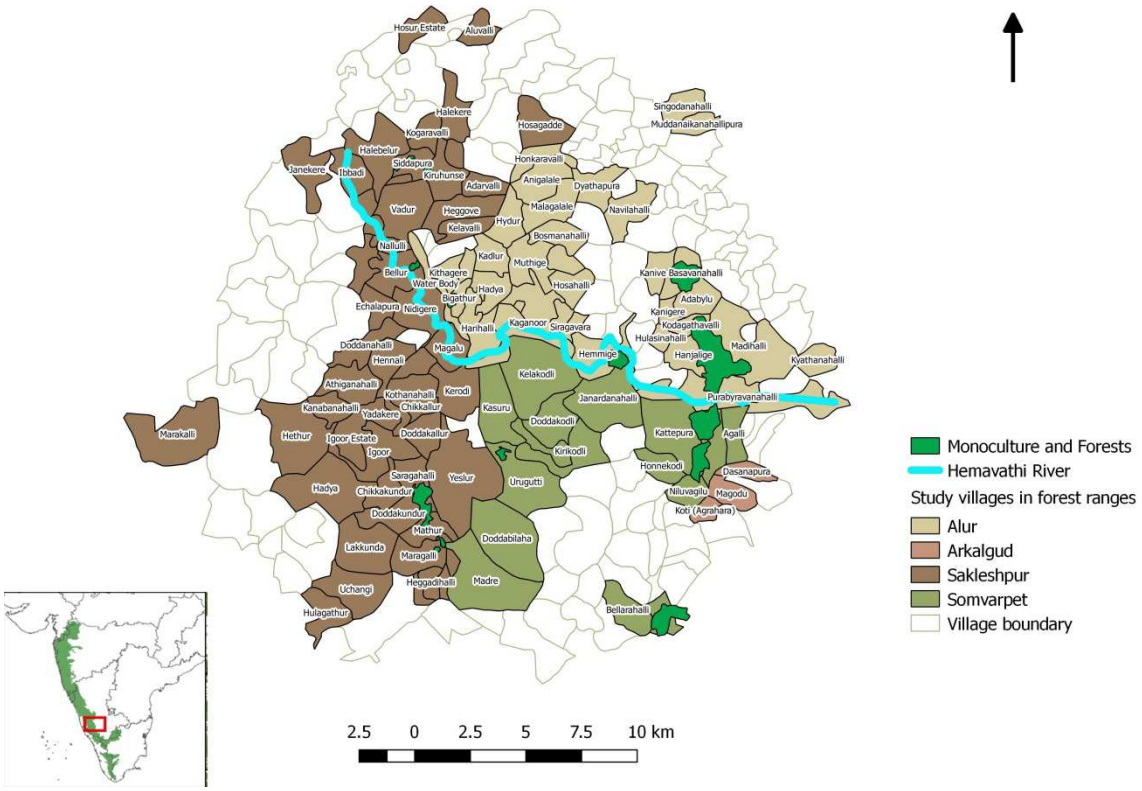


Figure 1: Map showing monitoring villages in four forest ranges of Alur-Kodlipet region

Study design and Methods

Tracking and distribution of elephants

Daily tracking of elephants was carried out through direct observations or indirect signs such as dung, tracks and feeding signs. We have also used information from the informants who are distributed across villages to locate elephant presence and conflict occurrence in the study region. Information on age-sex composition, herd size, habitat type, name of the place or village and GPS locations of elephants on regular intervals along movement path was systematically recorded. Identification of elephants carried out on as many individuals as possible using physical markings such as ear shape, persistent lumps, cuts on tail or ears, degree of ear folding etc. Mapping and digitizing of villages and extent of habitats was carried out using a combination of Survey of India topographic sheets and Google Earth maps, verifying with GPS locations collected during the field work. We have stratified the study area into six major habitat categories including coffee, monoculture refuges such as Acacia, teak, *Eucalyptus* and abandoned coffee plantation which are more than 10 years, agriculture (paddy, maize, ginger etc), backwater area of Hemavati reservoir, and other (townships, residential clusters of villages, and roads).

We have used all GPS locations to map distribution of elephants in villages in the study region. However, for most days, multiple GPS locations were obtained while recording locations of elephant herds. As locations taken in close proximity may not be independent, for all analyses, we

used a randomisation procedure to select only one day and one night GPS location for each 24-hour period. These data were used to estimate percentage use of habitats by elephants during the day and night time. The frequency of elephant locations in the six main habitat strata (coffee, monoculture refuge, natural vegetation, backwater, and other) were compared to an expectation based on the proportion of area under these habitats in the study region.

The study region receives both the southwest and northeast monsoons, between June and November every year. Hence, the year was divided into two main seasons: dry and wet. The dry season lasts from December to May and wet season spans between June to November. To study seasonal variation in elephant distribution and use of habitats, we used the frequency (percent) of elephant locations in each habitat type, in each season.

Investigating spatial and temporal patterns of human-elephant conflict incidents:

Incidences of crop and property damages by elephants were recorded by visiting the damage site whenever damage was noticed during daily tracking or reported by informants in the study region. Efforts were made to identify herds/groups and males involved in crop damage incidents by visiting damaged farms at night and seeking information from farmers/coffee planters. Details about each incident of damage was then entered in a conflict record form containing the information on date, time, GPS location, nature and type of crops damaged, name of the place and land owner's name, perceived costs etc. We defined a damage incident by the owner of the land and recorded instances of damage to one or more than one type of damage experienced by a single farmer in his/her property. The perceived loss was also noted based on the estimates indicated by each farmer/planter who incurred the loss for each conflict incident. We have examined the distribution of damages in relation to number of villages and type of habitat to identify conflict prone areas. We have analysed temporal distribution of damages across months to identify critical time periods in a year.

We also compared current levels of conflict to available data on the distribution and intensity of conflict in the same region. From earlier work (Bipin 2010 and KETF 2012), data pertaining to the number of compensation claims filed in a given village were available. These data were available systematically between 2000 and 2009 for most of our study villages in Alur, Arkalgud and Sakleshpur taluks, but available only sporadically for a few villages in Somavarpet taluk between 2010 and 2012. To enable a comparison between these data and the primary data we gathered, a few assumptions are necessary. First, we assume that past data on compensation claims filed with the Forest Department accurately index conflict incidents from that period, and that there was no over- or under-reporting. Second, we assume that our primary data on conflict incidents gathered from 2015-16 also accurately indexes conflict incidents in the villages we surveyed, without over- or under-reporting. In order to permit comparison across villages and taluks, we standardised conflict incidents per year and per unit area of the village.

Examining human fatalities due to elephants:

Incidences of human deaths due to elephants which occurred during five years between 2010-16were collected from Forest Department records of the Hassan and Kodagu divisions. Name, age and sex of the victim, GPS location of the incident, habitat type, time and place of incident were noted through field survey. Time of death occurrence was divided into two-hour intervals of 12 classes to estimate peak hours of human fatal occurrence in relation to time of the day. We have categorised age of the deceased into six age classes of 10-year intervals including < 20 years, 21 - 30, 31 - 40, 41 - 50, 51 - 60,> 60 years. Vulnerability of age class of people to fatal encounters with elephants for Hassan district alone was calculated by comparing proportion of observed fatalities with proportion of people in each age-class category. Reasons for human fatalities by elephants were estimated by requesting family members, neighbours, and friends to describe circumstances of fatal incidents in respective incident locality. Circumstances of each incident was then categorized based on the nature of occurrence into six major categories such as elephant presence unknown, lack of safety at home or work place which primarily includes reasons such as lack of in-house toilet facilities and safety measures at workplace, elephant drive (while driving elephants away from plantations/agriculture fields), inebriated, ignored warning of elephant presence, and unknown. These categories are not mutually exclusive as occurrence of fatal incidents may involve more than one reason. Such information is vital for developing appropriate mechanisms to prevent human fatalities due to elephants in future.

Developing participatory elephant information network

This study began with several informal and formal meetings with the local communities on some of the key issues and concerns with respect to the human-elephant conflict situation. These meetings were attended by farmers, coffee planters and workers from estates. These interactions helped in building an informant network with exchange of information about elephant presence and conflict occurrence between the research team and the local communities and ground staff of the state forest department..Information exchanged was verified during daily monitoring of elephants. Details of information shared by people over phone were systematically recorded in a daily call log register during the study period. The call log contained information about the date and time, name and location of the caller, the respective GPS location of the villager or elephant location, and the description of information exchanged. The nature of information was classified into three categories – a) **Convey**: communicating elephant locations to the research team b) **Report**: informing incidents of conflicts, and c) **Enquiry**: seeking elephant presence location from the researcher. We analysed the distribution of calls across months and time of the day to understand patterns and to compare with incidences of conflicts.

Results

Tracking elephants: Elephant distribution and use of the landscape mosaic

We tracked two groups of elephants and individuals numbering a minimum of 30 individuals (average herd size = 10.88, range 2–20) with 8 Adult males, 10 Adult females, 8 Juveniles and 4 young calves that moved across the fragmented landscape of the study region. Between March 2015 and February 2016, a total of 741elephant locations were obtained. Though these location distributed in all monitoring villages but a majority of elephant locations appear to be clustered within or close to forest fragments, monoculture refugees and abandoned coffee plantations. (Figure 2).

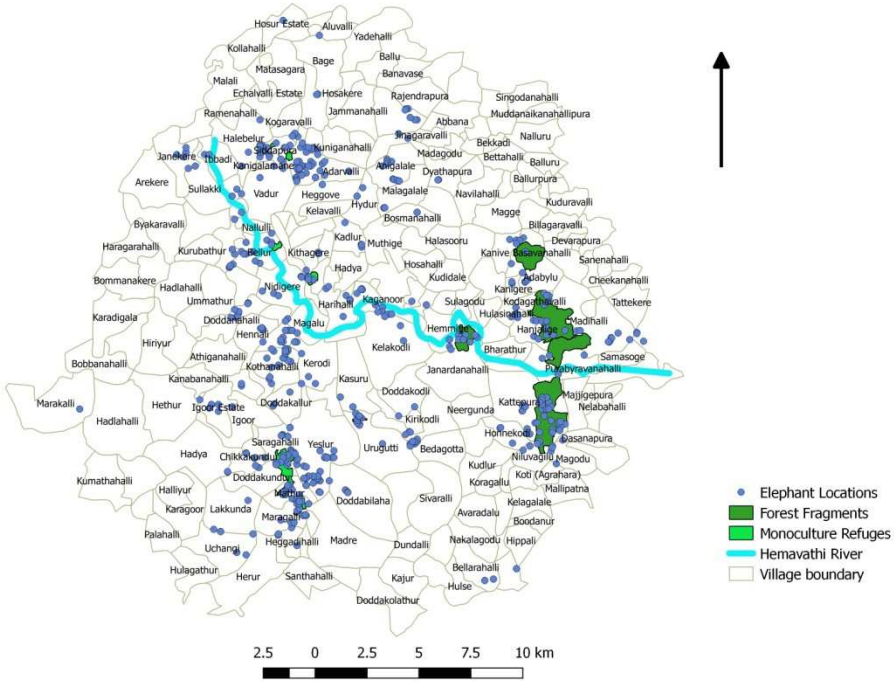


Figure 2: Distribution of elephant locations (blue circles) in relation to villages in the study region

Of the total number of locations obtained, a subset of 407 locations (not more than one daytime and one nighttime location per day per herd) which includes 314 day and 93 night locations from direct sightings, indirect signs, and conflict incidents were used to analyse habitat use by elephants in relation to the proportion of area available in each habitat type. There was a significant variation in overall use of habitats by elephants as assessed by these three data sets (χ^2 = 3650.7, df= 5, P <0.001). Elephants were seen most frequently in monoculture refuges (41.3%, n = 168) and forest fragments(15%, n = 61) as compared to the area available for these habitats together, which occupies less than 7% of total area in the study region. In contrast, percentage use was found to be less in coffee (28,7%, n = 117), agriculture (13.3%, n = 54), backwater (0.5%, n = 2), and others (1.2%, n = 5) against the available percentage of respective habitats (Figure 3a).

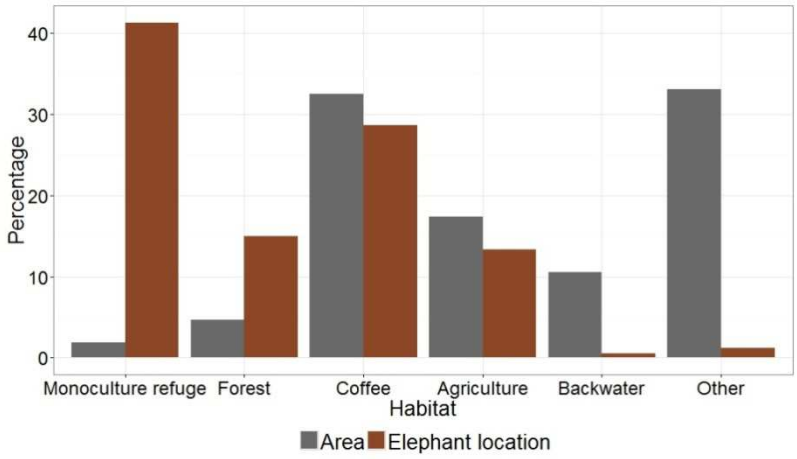


Figure 3a: Overall use of habitats by elephants in relation to the area available in each habitat type

However, elephants differed significantly in their use of habitats between day and nighttime (χ^2 = 223.2, df = 5, *P* <0.001; Figure 3b). During the day, elephants use of habitats were similar to overall patterns with high percentage of locations recorded in monoculture refugees (53.2%, n = 167) and forest fragments (19.4%, n = 61), whereas, at night, percent use of agriculture (53.8%, n = 50) and coffee (41.9%, n = 39) was higher than daytime with no records of elephant locations in forest fragments at night as compared to the availability of these habitats.

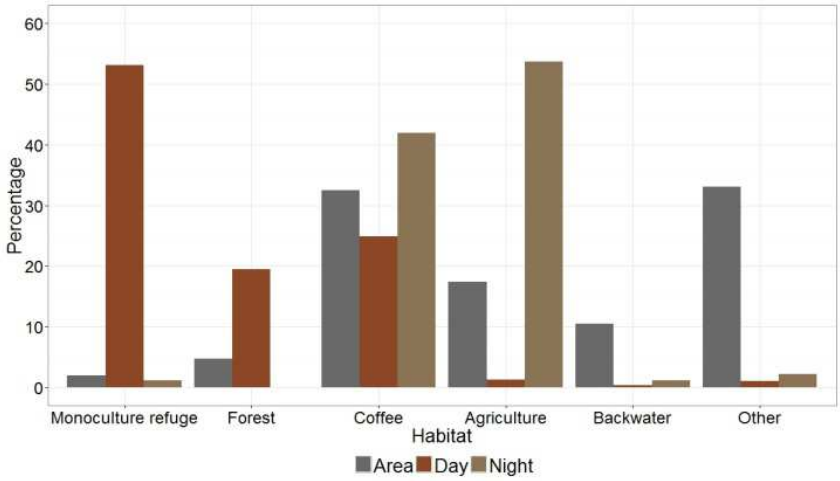


Figure 3b. Day and nighttime use of habitats by elephants in relation to area available in habitat type in the study region.

Seasonal use of habitats by elephants

Seasonal difference in the use of habitats by elephants within the study region was calculated separately for the dry (December-May) and wet (June-November) seasons (Table 1). Elephants used coffee and forest fragment more frequently in the dry season (35.3%, 21.4% respectively) than during the wet season (21.4%, 7.8%, respectively) while using *monoculture refuges* and agriculture more in the wet (50.5%, 17.7%, respectively) than during the dry season (33%, 9.3%, respectively). This

seasonal variation in use of *these four habitats* contributed to significant overall difference ($\chi^2 = 33.9$; df = 5; $p < 0.001$).

Table 1: Frequency of elephant locations during dry and wet seasons in various habitats in the fragmented landscape of the study region

Habitat	Dry		Wet	
	Observed frequency (%)	Expected frequency	Observed frequency (%)	Expected frequency
Monoculture refuge	71 (33)	89	97 (50.5)	79
Forest fragment	46 (21.4)	32	15 (7.8)	29
Coffee	76 (35.3)	62	41(21.4)	55
Agriculture	20 (9.3)	28	34 (17.7)	26
Backwater	2 (0.9)	1	0 (0)	1
Other	0 (0)	3	5 (2.6)	2
Locations (*N*)	215		192	

Human-elephant conflict

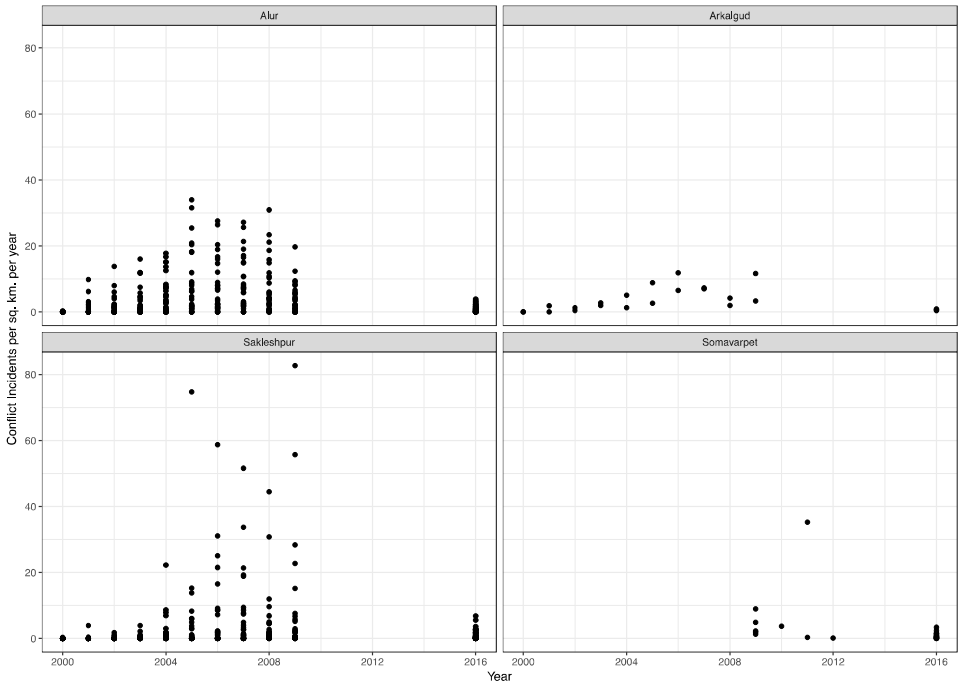
Nature of damage

A total of 190 incidents of damage by elephants were recorded in a period of 12 months (between March 15 – February 16), Of the total conflict incidents, there were 222 instances of damages (an incident may involve more than one instance of damage to either different crop types or property, experienced by a person)noticed to crops, plantation crops such as coffee, banana, areca etc., and property. Among the damages to agriculture crops, 99 instances of damages occurred to paddy followed by 10 instances to maize, and six damages to finger millet. Among plantation crops, 49 instances of damages to coffee bushes, 47 damages to banana plants within coffee area, three instances in Areca, and one in coconut. Seven instances of property damages by elephants which

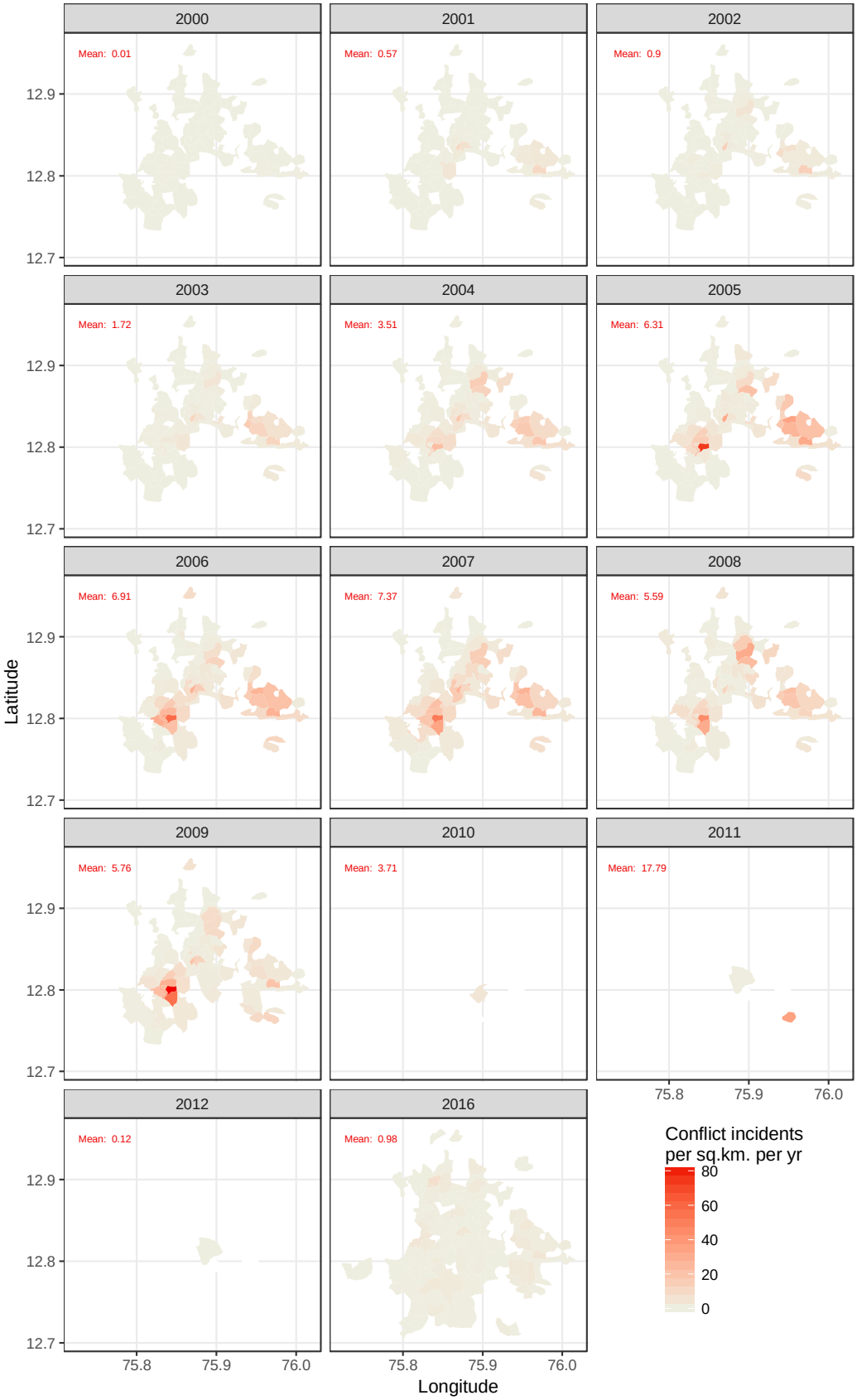
include sprinkler systems, gates, a four wheel vehicle, and water tank etc. Elephant herds were involved in more number of damages (n = 152, 80%) than males (n = 21, 11%). Identity of individuals could not be established in the remaining 17 conflict incidents (9%)

Spatio-temporal trends in human-elephant conflict

A total of 4624 compensation claims were filed with the Forest Department for elephant crop damage incidents between 2000 and 2009, ranging from 3 to 871 claims per year in 57 villages under four taluks in the Hassan–Kodlipet region of study area. There were 865 claims filed for the first five year period between 2000-04 which increased by 4.3 fold during the latter half, between 2005–2009 (n = 3759). Taluk-level data indicated both a high and variable level of conflict up to 2009. Levels of conflict per square kilometer per year observed in villages in four taluks in 2016 were consistently lower than in the 2005–2009 period (Figure 4a). Significant decline in number of conflict incidents was evident in Alur and Sakaleshpur taluks. Temporally, in most villages that reported high frequency of conflict incidents per square kilometer per year between 2005 and 2009, our data show a significant decline in conflict extent and intensity (Figure 4b).The number of recorded incidents during the study period between 2015-16 seem to closely reflect conflict levels in 2002.



4a. Spatial distribution of conflict incidents per year per unit area in study villages of four taluks in Hassan-Kodlipet region



4b. Temporal distribution of conflict incidents per year per unit area in villages of four taluks in Hassan-Kodlipet region**.**

Seasonal distribution of conflict

Conflicts were noticed in all months ranging between 1 - 56 incidents per month with an average of 16 incidents per month. A high percentage of damages (78%, n = 148) were noticed in a six month period between August - January. However, occurrence of 102 incidents (53.7%) in a three month period between November and January denotes the peak conflict season (5a).

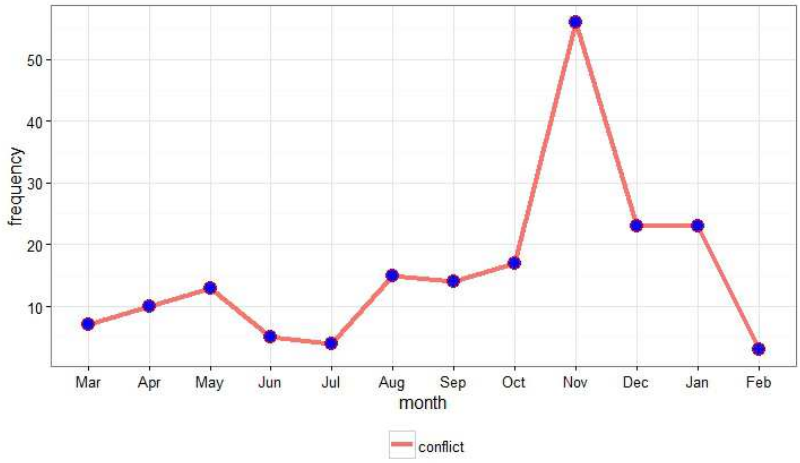


Figure 5a:Monthly distribution of conflict incidents in the study region

We have carried out further analysis on instances of crop damage by elephants (n = 222) occurred to three major crops such as Paddy, coffee, and banana across months (Figure 5b). Damages to these three occurred throughout the year but significantly peaking for paddy during August and December (n = 91, 92%) and with small peaks for plantation crops such as banana in January (n = 21, 44.7%) and for coffee in December and January (n = 19, 39%).

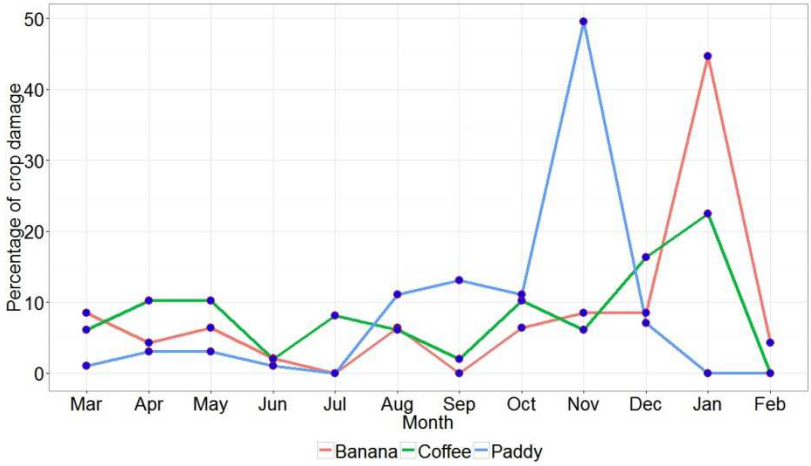


Figure 5b:Monthly distribution of elephant damages to major crops in the study region

Human deaths due to elephants

A total of 30 incidents with an average of five incidents per year occurred between 2010-16. Incidents of human fatalities were widely distributed across the region. More men (n = 24) than women (n = 6) lost their lives in direct encounters with elephants. No pattern observed in occurrence of deaths across

months which indicate that encounters with elephants may likely to occur during any day of a month in a year. However, time of the day seems to influence occurrence of fatal incidents. 63%of fatal incidents occurred between 6 - 10 AM in the morning hours (n = 11) and 4 - 8 PM (n = 8) during evening hours denotes sensitive time periods (Figure 6).And also, 67% of people (n = 20) lost their lives on roads and trails when they move between work place and home. Remaining incidents occurred in coffee (n = 3), agriculture fields (n = 2), Reserved Forests (n = 1), uncultivated land (n = 1), and within residential premises (n = 1). Place of incident occurrence was not known in two cases .

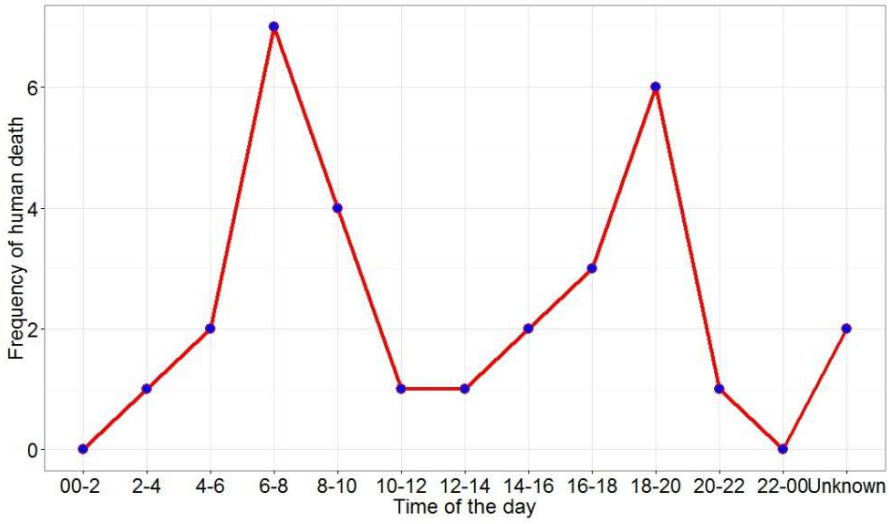


Figure 6. Graph showing the distribution of human fatalities due to elephants in relation to time of the day

Vulnerability of age class of rural population to fatal encounters with elephants

Most people who lost their lives in direct encounters with elephants were between 40 - 60 years of age (n = 20, 66.7%). However, we have compared only number of human fatal incidents due to elephants for Hassan district alone (n = 23) with expected frequencies in relation to proportion of people distributed across age classes at the district level (N = 13,98,645 people obtained from population 2011 census data of Government of India). The proportion of people who lost their lives in the age category of 40 – 60 was much higher as compared to rural population in the Hassan district. This reveals that 40–60 age group people are more vulnerable to fatal encounters with elephants than other age groups of people in the district. This age group largely constitutes the working class population, where chances of encountering elephants may be high (Figure 7).

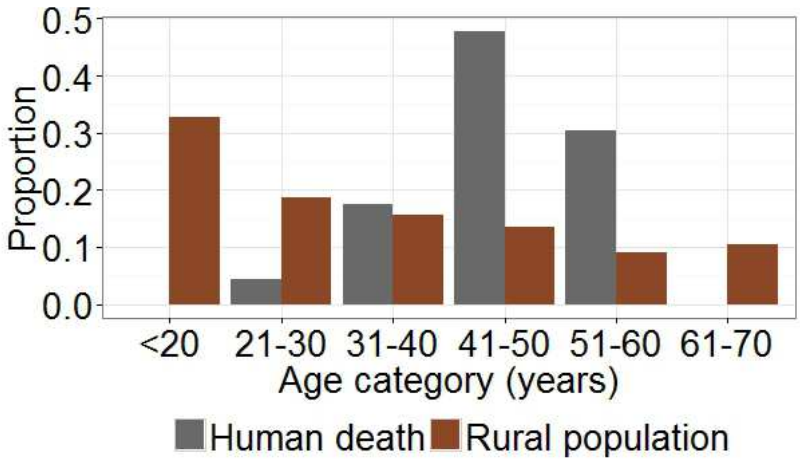


Figure 7. Distribution of proportion of human deaths and rural population in relation to age category in the Hassan district

Circumstances of human deaths due to elephants

A majority of human fatalities were due to lack of prior information about elephant presence and safety measures such as lack of in-house toilet facilities at home and work (71%, Figure 8). Other reasons such as elephant drive (drive away elephants from the fields), ignored early warning of elephant presence, and inebriated state of a person resulted in remaining fatalities. In two cases of the total fatal incidents, reasons were not known.

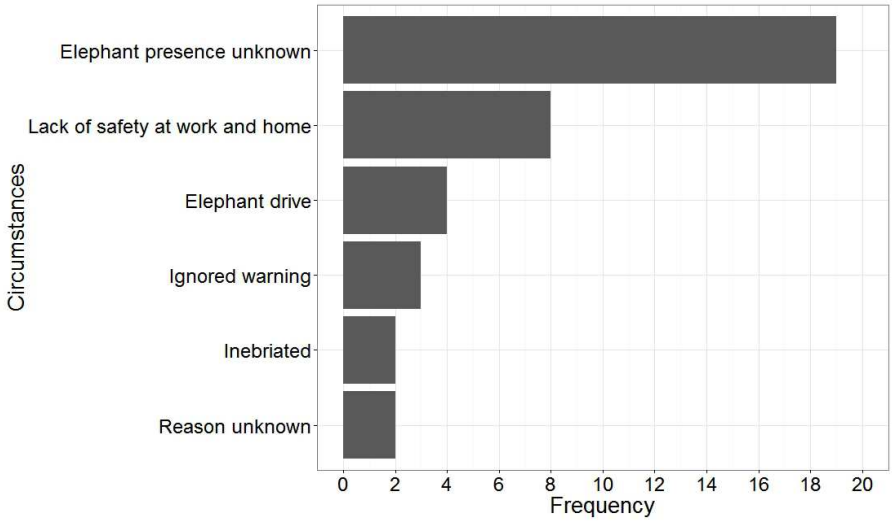


Figure 8: Circumstances of human fatal accidents with elephants in the study region

Developing participatory elephant information network

We have developed a network of 178 informants from 75 villages in the study region who would inform about elephant presence and conflict incidence reporting in the monitoring villages. Out of the 85 villages monitored, a total of 202 phone calls were received from 45 villages ranging between 3-37 calls per month with an average of 17 calls per month. Information from the call log shows that 125 calls were about people conveying elephant locations (62%), 59 calls reported incidents of crop

damage (29%) and 19 calls were seeking information about elephant locations (9%).Nevertheless, number of calls received from people varied significantly in relation to the time of the day with 53% of calls were between 6 AM and 10 AM (n = 108, Figure 9).

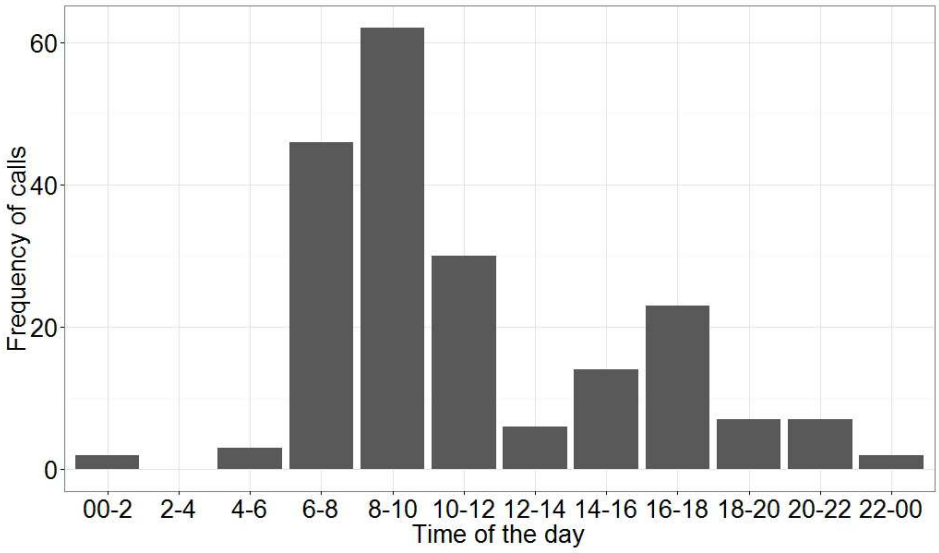


Figure 9. Distribution of phone calls received from people in relation to time of the day

Discussion

Elephant use of habitat mosaic

In contested landscapes such as Alur-Kodlipet region mitigating human-elephant conflict is one of the high priority issues for conservation of elephants outside Protected Areas. Understanding the needs of elephants and people is essential to arrive at possible pro-active measures to mitigate conflicts and may be helpful to promote human-elephant coexistence in this landscape. The Alur-Kodlipet region has been intensively and widely used by breeding herds and males. In a plantation-agriculture dominated landscape, elephants used remnants of forest fragments and monoculture refuges such as acacia and *Eucalyptu*s plantations more than other habitats when considered relative to availability. However, elephant usage of habitats was also influenced by the time of the day, with greater usage of monoculture refuges and forest fragments during daytime and agriculture and coffee at night. Forest fragments and monoculture refuges though they represent less than 7% of total landscape, contained secondary vegetation and tree canopy, could play a key role for elephants in providing shelter and forage for elephants but with no water resources during the day time. We also acknowledge that elephant use of canopy covered habitats during the day may have been influenced by activity of people in coffee plantations and agriculture fields. At night, elephants seem to access water in agriculture ponds (*personal observations*), palatable crops such as paddy, maize etc., and banana plantations in coffee habitat which resulted in crop damage while moving between areas of cover (Sukumar 1990). However, in absence of forage and shelter areas, elephants may be forced to increase use other habitats of coffee and agriculture which may intensify human-elephant conflict in the study region. On the other hand, elephants used habitats such as backwater and others including village

residential areas and roads less frequently, probably as a strategy to avoid risks involved in open areas and pressures from people (Granados *et al.* 2012). Seasonally, availability of tree canopy along with secondary vegetation and grass in coffee, forest fragments, and monoculture refuges to be more important habitats which appeared to provide cover, fodder, and water for elephants (Kumar *et al.* 2010; Bal *et al.* 2011). Hence, retention and protection of these habitats are important for elephants in the region.

Human-elephant conflict

The study region had experienced episodic removal of elephants as a measure to deal with human-elephant conflict situation. This operation resulted in 17 individuals taken into captivity and remaining few were translocated to distant forest habitats. Incidents of crop damage increased sharply in the latter half of the 10-year period between 2000 - 2009. post 2005 up to 2009 which forced the state forest department to initiate elephant capture and removal operation in the year 2013-14. A study by Fernando *et al*. (2012) in Sri Lanka has revealed that elephant capture and translocations have neither helped in conservation of elephants nor reduced incidents of conflicts.

Though, the number of conflict incidents seem to be lower during post elephant capture period (2015-16), employing such extreme measures needs to be carefully considered in terms of its impact on long-term viability and, moral and ethical aspects of elephant conservation at large. The study region had experienced first major capture and removal operation during 1986-87 which had minimized conflict incidents to low levels for a decade period and gradually increased to high levels in 2011 (Appayya and Desai 2007, KETF 2012). The lower number of conflict incidents in the present study is comparable to the number of crop damages that occurred in 2003. This respite in reduced incidents of conflicts appears to be a stop gap as large number of elephants moved from neighbouring areas into the study region during the post capture operation in 2013-14. This may possibly aggravate human-elephant conflict situation in future. Besides, capture and removal of elephants often ignore inter-individual relationships among elephants as these measures are employed with no prior knowledge on sociality of individual elephants in a herd. Secondly, moral and ethical aspects of constricting free ranging elephants into limited natural resources and restricted environments and its impact on physio-social consequences of reduced sociality among individual elephants, poor body condition, and stereotypic behaviour of elephants (Pinter-Wollman *et al*. 2009; Vanitha *et al*. 2015) need to be seriously considered. Nevertheless, where attempted, proactive measures such as early warning systems, which try to reduce encounters between people and elephants, especially when they include local communities, have not only reduced frequencies of conflict but also elevated people's tolerance to elephants. (Graham *et al.* 2011; Kumar and Raghunathan 2014). Hence, there is an opportunity, at least in the short-time, to adopt pro-active interventions before conflicts increase to high levels in near future. Such a step may also help transforming conflict areas into safe zones for people and elephants.

Incidences of damages were seen in most part of study region but there were few villages which were highly prone to conflicts than others. Further investigation is required to determine spatial and landscape factors and understand elephant distribution that would influence occurrence of elephant damages in high conflict prone villages. Paddy had experienced most number of damages as it is grown widely in valleys among coffee plantations in the study region. Majority of crop damage incidents were caused by herds than males alone in the study area unlike in many other parts where bulls are involved in high incidents of conflicts (Haturusinghe and Weerakoon, 2012). In the study region, when elephant moved out of forest fragments or monoculture refuges, it is inevitable for them to move through paddy fields in many places which resulted in high incidence of damages to paddy. Crop damage by elephants increased during transition from wet to dry season where the number of incidents were high in a six month period between August and January with a peak between November and January. Though, damages to three major crops in the study region occurred throughout the year, percentages of elephant damages to paddy was more during August and December due to trampling and feeding and also a preference for matured crops close to the harvest period (Sukumar 1990; Nyhus *et al*. 2000). Coffee and banana are annual crops and grown together in the same area. Elephants are known feed on ripened coffee berries (Bal *et al*. 2011) and palatability of banana plantations (Webber *et al*. 2011), damages to these plantation crops appear to be high during December and January as compared to other months in a year. Most of the crop damage incidents occurred at night (dark hours of the day) where people were unaware of elephant incursions into crop lands. A majority of farmers who would grow paddy only once a year which would last for 4 - 6 months before harvesting the crop. Human-elephant conflict resolution is a complex issue which warrants multiple approaches to mitigate conflicts between people and elephants. A large part of coffee plantations are protected with power fences which deflect elephant movements into unfenced regions of paddy fields, leading to damages to crops. Paddy is largely owned by marginal farmers and grown as a seasonal crop lasting for four to six months between August and December, a period of high incidents of crop damage by elephants. Experimental trials with temporary paddy field power fences around selected agriculture farms based on careful assessment of land-use features which are managed by local communities may be a possible option to minimize crop damages by elephants. Such initiatives over a long-term have been positive in Sri Lanka, benefiting farmers to protect paddy during cropping season and facilitate elephants movements during non-cropping season (Prithviraj Fernando *pers. comm.*)In most places in the study region, farmer's houses are located far off from crop lands. People were unsure of elephant incursions into their crop lands at night though elephants were known to be present in same region. During our interactions with farming community, people have expressed the need for in advance intimation systems that would alert people of elephant entries into crop lands (Sitati and Walpole 2006; Hedges and Gunaryadi 2009). Sitati *et al*. (2005) identified early detection of elephants before they enter into farm lands is key to avoid damages to crops. This is because once elephants enter a farm, they cause significant damage to crops and difficult to drive them away from cultivated farms. Early detection and communication about elephants may help

people to take appropriate safer methods of making loud noises in groups, use of torches to prevent them entering crop lands (Hedges and Gunaryadi 2009). However, caution must be borne while implementing such preventive measures to deflect elephants away from one's crop land may pose risk to other's crops in the vicinity. They need to be scientifically tested for its efficacy and benefits to farmers by involving local community with prior knowledge of positive and negative consequences.

Human deaths due to elephants

Loss of life due to elephants has been one of the serious conservation issues in the study region. Incidents of loss of human life due to elephants have caused fear and trauma and triggered negative attitude among local communities, who often engage in undesirable reactive measures against elephants. These include chasing of elephants using trucks, throwing objects such as stones or fire brands or thunder flashes, bursting crackers, and sometimes indulging in retaliatory killing of elephants which are detrimental to elephants. Such reactive measures, may neither be beneficial to local people nor helpful for conservation of elephants, besides negatively affecting elephant behaviour in altered landscapes (Whitehouse and Kerley 2002; Burke *et al.* 2008; Kumar and Singh 2010). The qualitative and unquantifiable losses such as human death, reduced sleep, inability to attend school by children, absenteeism at work due to guarding of property and life, and psycho-social stress may exceed the costs of material damage commonly associated with human-elephant conflicts (Madhusudan 2003; Sitati *et al.* 2012; Barua *et al.* 2013).

In the study region, more men than women lost their lives in direct encounters with elephants. Although no seasonal patterns were observed in occurrence of human deaths, in terms of diurnal patterns, early morning and late evening periods seem to be critical for human safety, which is related to working hours of the day. A majority of casualties were labourers who work in coffee estates and in farm lands. Most coffee estates and few agriculture farms were fenced with solar power fences leaving roads and residential colonies unprotected. This may force elephants to use linear habitats such as roads, trails and streams to move between tree covered areas, which people too use to commute between home and work. In many places, workers and school children have to use roads and trails for long distances. Given the lack of visibility through coffee bushes and curvilinear nature of roads, locating elephants on roads and trails becomes extremely difficult. This has resulted in high number of fatal incidents on roads and trails. Hence, there is an urgent need to provide transport and street light facilities and removal power fences in certain key locations would help decrease potential risk of people encountering elephants, and also facilitate free passage for elephants. The age of the person seems to be critical factor associated with fatality in direct encounters with elephants. Our study reveals that a larger fraction of people aged between 40 - 60 years (who constitute the main working demographic) had lost their lives to elephants than other age groups. This warrants regular interactions with people to build awareness and sensitization about the criticality of age in direct encounters with elephants in the region.

Understanding circumstance of human deaths is crucial to develop appropriate human safety measures and suggest precautionary steps to avert direct encounters with elephants. A majority of people lost their lives in surprise encounters with elephants due to reasons such as lack of toilet facility, transportation, street lights on critical stretches of roads, and no prior intimation about elephant movements to workers in coffee plantations. Resorting to confrontation methods of chasing away elephants from crop lands, bursting crackers etc., will lead to habituation of elephants to such measures and increase the risk of injury and death as the aggression levels increase on both sides. When inevitable, prior intimation of such operations need to be communicated to people before execution to avoid potential injury or fatalities.

General working hours for people in agriculture fields and coffee plantations would be between 6 AM and 4 PM. As elephants move only during late hours of the day, many times, people are unaware of their presence in their localities. Early intimation, about elephant locations and their movement, to people before their routine activities start, or during late in the evening while returning home would help avoid possible direct encounters. This would require developing an effective Elephant Information Network (EIN) with the involvement of local community and Forest Department field staff, which would form a reliable source of elephant location information. Our study indicates that a majority of calls received from people were about conveying elephant presence information during early morning and late evenings, it would be possible to disseminate the same to cover many others by using simple and locally adoptable technical interventions as implemented elsewhere (Kumar and Raghunathan 2014). Such an initiative may not only help increase safety of people but also would promote community participation in the management of human-elephant conflict.

Elephant Information network

By and large, local communities often feel disempowered about participating in measures to mitigate or manage conflict, especially with large, endangered wildlife. This sense of alienation from being able to define the problem, or formulate a solution, often deepens their sense of conflict. Therefore, measures that enhance local participation in problem identification and solution building may, in general, be desirable.

Active participation by local communities in sharing information about elephant presence, conflict occurrence, and seeking help from the Forest Department staff to protect farm landsis evident from the results. Higher percent of calls received during May and July and November and January coincides with peak elephant activity and conflict occurrence. More than 50% of calls from people during morning hours also coincide with sensitive period of human deaths in the study region. This indicates people's sustained participation in communicating about elephant presence information and also helpful for establishing early warning systems (Kumar and Raghunathan 2014). It will also help develop a greater sense of shared responsibility about conflicts, reduced tension, preparedness to avoid conflicts with elephants, and help build positive relationships between local communities and

Forest Department field staff for timely management of conflict. There is also a potential opportunity to develop elephant and crop protection groups (ECPGs) along with the Forest Department field teams for effective and timeliness of elephant information network which is critical for positive human-elephant conflict management (Graham *et al.* 2011). Coordinated efforts by local people and wildlife authorities would also help prevent elephant movements into crop lands and reduce incidences of damages.

Recommendations

The study recommends the following steps which may be adopted for elephant conservation and effective management of human-elephant conflict in the Alur-Kodlipet region.

- Forest fragments and monoculture refuges such as Acacia and *Eucalyptus* plantations and abandoned coffee act as important refugia for elephants. Hence, retention of these habitats elephants would help elephants avoid human disturbance and minimize interactions with people.
- Crop damage by elephants occur mostly at night, when people are unaware of elephants entering their farm lands. Early detection of elephants using sensor based technological interventions involving local community and forest field staff may help prevent elephant incursions into crop lands. This will empower people with early intimation and promote active participation in conflict management even if the outcome of reducing conflict/damage remains elusive.
- Capture and removal operations cause pain and trauma, and ethical and moral concerns for elephants. This measure requires careful thought in its exercise in terms of benefits to elephant conservation and conflict mitigation in the long run.
- The study region has a good network of mobile connectivity. Early warning systems such as bulk SMS and outbound voice calls to alert people about elephant locations over mobile phones and installation of GSM based digital display boards on critical stretches of roads frequently used by elephants and people may be useful to avoid surprise encounters with elephants. These systems have been successfully implemented in high conflict prone areas of Tamil Nadu and Kerala which resulted in significant reduction in incidences of human-elephant conflict.
- Establishment of Rapid Response Team, a dedicated team equipped with vehicle, torch lights etc., is needed for timely presence and speedy response time to people's calls may help develop positive relationships between local community and forest department. Such steps have been well adopted by forest departments of Tamil Nadu and Kerala in key high conflict prone areas.
- Efforts should be made to involve local people in establishing Community Informant Network Units (CIN units) and Elephant and Crop Protection Groups (ECPGs) who would act as key informers of elephant presence and also help with the rapid response teams to manage human-elephant conflict effectively.
- Sensitization and awareness about elephant locations and their movements to local communities and their active participation in the management of human-elephant conflict is critical to adopt

safety measures to protect life and property and also help increase tolerance in people towards elephants.

Recent interaction meetings with local community

We have held formal and informal interaction meetings with local people including small scale coffee planters, village farmers, and representatives of grama panchayat during the last one year. We have shared the results of research with people and discussed about possible pro-active measures that would help reduce incidences of conflicts. People have expressed that addressing loss of life in direct encounters with elephants besides damage to crops has been one of the priority issues. During the meetings, though some people have opted for capture of few identified elephants but a majority of attendees have indicated that large scale removal of elephants may not be a viable option for conflict solution. This was because of past elephant captures have not yielded positive impact on mitigating human-elephant conflict. In our meetings, people have also mentioned that early intimation about elephant presence and their movement could help increase their safety. In this regard, there was a positive response to experimenting with early warning systems such as alert text and voice alert calls over mobile phones and installation of alert indicators such as warning lights and digital display boards on critical junctions and roads.

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